Sample Return Systems for Extreme Environments

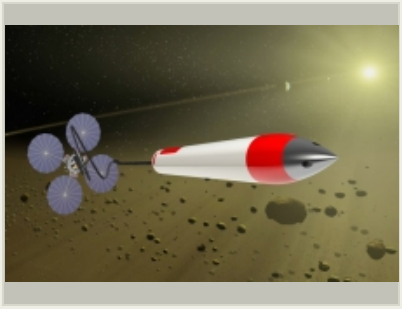
Completed Technology Project (2013 - 2015)

Project Introduction

In Phase I we were able to demonstrate that sample return missions utilizing high velocity penetrators (0.1- 1 km/s) could provide substantial new capabilities for sample return missions at lower cost than soft landing techniques. Key innovations include new energy absorbing material, and utilization of tethers for deployment of the penetrator and extraction of the sample, to reduce the DeltaV requirements while maximizing the probability of return , and minimizing the components that could be damaged by a hard impact. The work also incorporated proof-of-concept field testing of components under relevant environments. The proposed work seeks to (a) expand the modeling of the interaction of the penetrator with the surface material so that penetration depth can be more accurately predicted for different types of materials likely to be encountered at different solar system objects, (b) enhance the properties of the energy absorbing materials to handle speeds up the upper ranged for planned impacts, and (c) to perform field testing of the tether extraction of the return sample and refine the simulations of the tether dynamics. In addition, the proposed work has the potential for allowing electronic enabled penetrators which could for example be used for seismic imaging of the interior. Because of the ability to provide multiple samples, the full system which would be developed in greater detailed in Phase II will provide unprecedented analysis of the interior structure of a solar system object. Our ability to perform modeling, lab testing and field experiments will enable the system to go for TRL2 to TRL4/5 within 2 yrs.

Anticipated Benefits

Sample return missions offer a greater science yield when compared to missions that only employ in situ experiments or remote sensing observations, since they allow the application of more complex technological and analytical methodologies in controlled terrestrial laboratories, that are both repeatable and can be independently verified. The successful return of extraterrestrial materials over the last four decades has contributed to our understanding of the solar system, but retrieval techniques have largely depended on the use of either soft-landing, or touch-and-go procedures that result in high ▲V requirements, larger spacecraft mass ratios, and return yields typically limited to a few grams of surface materials that have experienced varying degrees of alteration from space weathering. Hard-landing methods using planetary penetrators offer an alternative for sample return that significantly reduce a mission's ▲V and mass ratios, increase sample yields, and allow for the collection of subsurface materials, and lessons can be drawn from previous sample return missions.



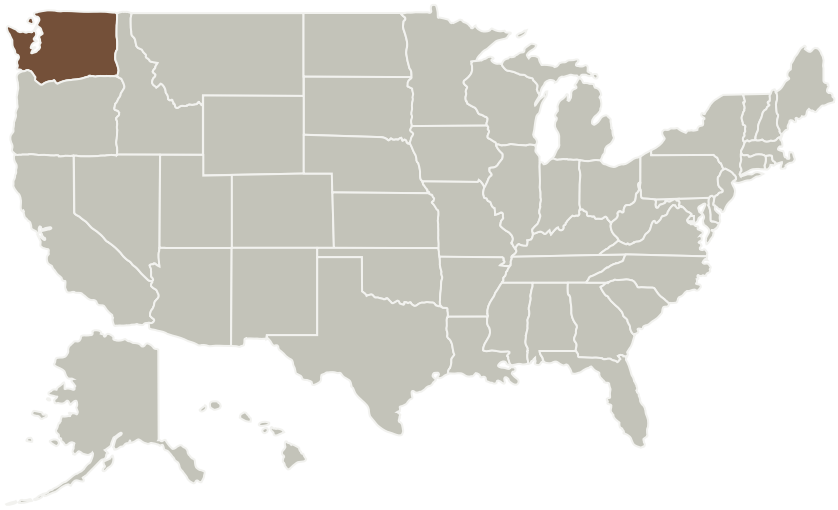
Sample Return Systems for Extreme Environments

Table of Contents

Sample Return Systems for Extreme Environments

Completed Technology Project (2013 - 2015)

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Washington-Seattle Campus(UW)	Lead Organization	Academia	Seattle, Washington
Tethers Unlimited Inc	Supporting Organization	Industry	

Primary U.S. Work Locations
Washington

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Washington-Seattle Campus (UW)

Responsible Program:

NASA Innovative Advanced Concepts

Project Management

Program Director:

Jason E Derleth

Program Manager:

Eric A Eberly

Principal Investigator:

Robert M Winglee

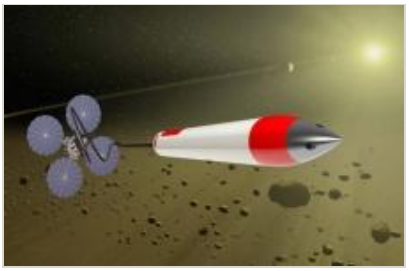
Co-Investigator:

Robert Hoyt

Sample Return Systems for Extreme Environments

Completed Technology Project (2013 - 2015)

Images



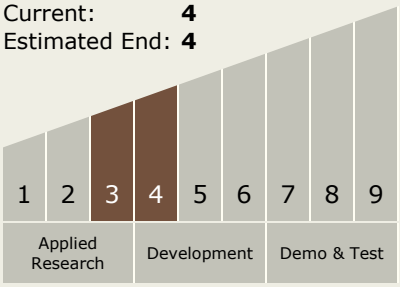
Project Image Sample Return Systems for Extreme Environments
Sample Return Systems for Extreme Environments
(https://techport.nasa.gov/image/102119)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Technology Maturity (TRL)

Start: **3**
Current: **4**
Estimated End: **4**



Technology Areas

Primary:

- TX04 Robotic Systems
  - TX04.3 Manipulation
    - TX04.3.4 Sample Acquisition and Handling

Target Destinations

The Moon, Mars, Others Inside the Solar System